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Henry W. Robison
and Michael V. Plummer

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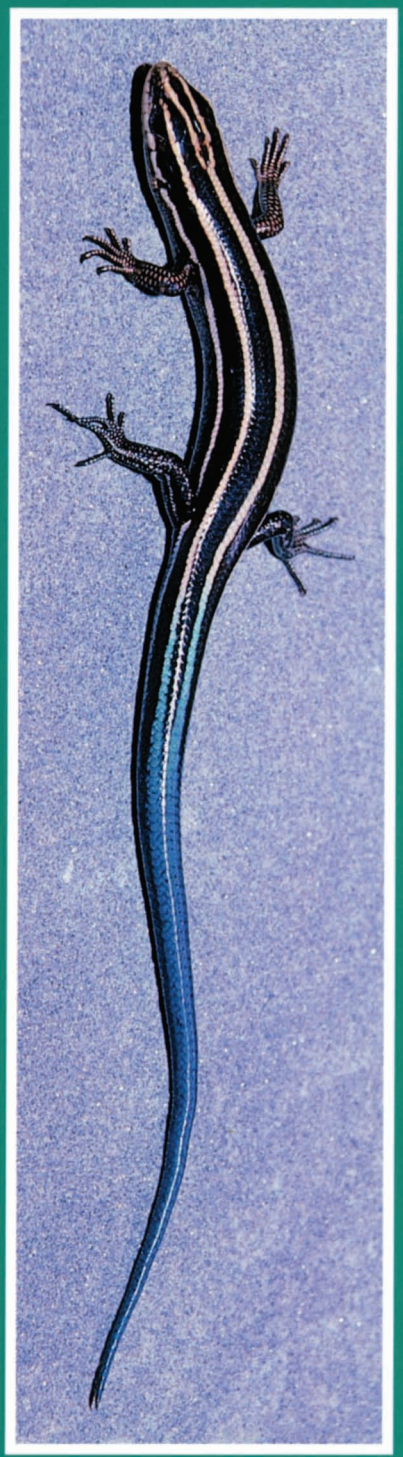

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ILLUSTRATED BY RENN TUMLISON

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To my sons, Ryan and Kyle, for accepting my vocation with enthusiasm; to Hazel Hickey and the late Tom Hickey for their ceaseless encouragement and support; to Mom and my late father, whose decisive move from the St. Louis suburbs to the Arkansas Ozarks was pivotal in nurturing my boyhood fascination for herps and in molding my professional growth; and finally to my wife, Joy, who shared my visions and endured many years of personal sacrifices so that this book could be completed.

—Stan Trauth

To Mom and Dad, Avon, Doll, Montene, Coach Ropp, George, and Rudy, eight special people who taught me discipline, instructed me in dedication to purpose, supported my joy of learning, and encouraged my love of the natural world.

—Henry Robison

To my mother, who, despite her deep fear of snakes and other crawly things that little boys often bring home, enthusiastically encouraged me as I developed from boy herpetologist to professional scientist. To this dear and wise lady I owe, to a large extent, whatever measure of professional success I enjoy today—I miss her. Also to Sharon, Melissa, and Scott, my chief cheering section and critical review board, who supported and endured the passion of the "least-weird herpetologist" they knew.

—Mike Plummer

Contents

REPTILES

Foreword

Shortly after completing my Ph.D. at Arizona State University and accepting an assistant professorship at Arkansas State University, I met a graduate student named Stan Trauth at a professional meeting. It was clear at that initial meeting that Stan was driven to study reptilian reproductive biology and anything involving the herpetofauna of Arkansas. When I made the decision to accept a position in Wisconsin, Arkansas State University was fortunate to secure his services. While at Arkansas State I kept hearing, from many sources, about a recent graduate named Henry Robison, who was just outstanding. Although I have not had the opportunity to work with Henry, I was able to provide modest funding to assist his fieldwork, which led to the publication of *Fishes of Arkansas* and this book. Mike Plummer was known to me, through colleagues at the University of Kansas, as an exceptional field zoologist. He visited our North Fork of White River research site and within minutes of borrowing and donning a wetsuit was catching Ozark hellbenders *(Cryptobranchus alleganiensis bishopi)* as efficiently as anyone I've seen. A memorable herpetological event with Mike occurred during a spring meeting of the Arkansas Academy of Sciences in Little Rock. Mike and I decided to join a small group listening for calls of the bird-voiced treefrog *(Hyla avivoca)* in a wet forest that was being invaded by a housing development. We didn't hear any calls, but discovered numerous cottonmouths *(Agkistrodon piscivorus),* which I needed for a venom gland study. We had no cloth bags, snake hooks, or other collecting equipment. However, being resourceful we scrounged paper bags, modified branches, and used a nonrecommended technique to collect a series of these pitvipers. This book is the result of the efforts of these three dedicated zoologists, each of whom have decades of experience with the species of amphibians and reptiles that inhabit Arkansas and are in Arkansas habitats.

As a reader you will be immersed in the historical studies of Arkansas amphibians and reptiles, the rich diversity of species, their habitats, and some of the problems that need to be resolved to preserve this diversity. The state's ecoregions are portrayed with carefully selected color photographs that typify the region and are linked with characteristic herpetofauna. The individual species accounts for all of the contemporary amphibians and reptiles include a species description, habitats, habits, conservation status, and distribution. They are supplemented with line drawings, including plotted localities for known authentically identified and voucher specimens on the state map, coupled with a separate map showing the distribution in the United States. The accounts are also richly enhanced with quality photographs of the adult form, eggs, unique anatomical structures, microhabitat, social behavior, and intraspecific variation.

The dichotomous keys are among the most outstanding and useful features of this book. As expected, the keys to adult salamanders, frogs, turtles, lizards, and snakes are well supplied with line drawings that readily differentiate the alternative pathways to correct identification. The keys and pictorial guides to the ontogenetic stages of live larvae or larviform adults of selected salamanders and live larvae of selected anurans are unexpected examples of the authors' great effort to make this book a tool that almost anyone can use to identify Arkansas amphibians and reptiles. The substantial glossary efficiently defines the technical terms not clarified elsewhere in the text and a large and comprehensive literature cited completes this impressive contribution.

This book successfully accomplishes goals established more than two decades ago. It serves as an excellent and comprehensive guide to Arkansas amphibians and reptiles and is an important reference for scientists, teachers, students, and any of the state's citizens with interests in biodiversity, conservation, wildlife management, ecology, and natural history. It will have a broad appeal and importance regionally and should serve as a contemporary model for state or regional contributions in herpetology nationally. I am also certain that this publication will be a catalyst stimulating herpetological research and education. Read, enjoy, and enrich your understanding of amphibians and reptiles.

Max A. Nickerson
Professor and Curator
University of Florida/Florida Museum of Natural History

Preface

"A Review of the Amphibians and Reptiles of Arkansas," the state's only comprehensive herpetological guide, appeared in 1957. Within the introductory remarks to this brief but timely study by Herndon G. Dowling, Samuel C. Dellinger, then curator of the University of Arkansas Museum, stated that "it is hoped that this work may be continued and expanded so that eventually a comprehensive handbook containing keys, descriptions, distribution maps, and life-history notes may be issued." Although it has taken nearly 47 years, Dr. Dellinger's request for a contemporary guide to the state's herpetofauna has finally been fulfilled.

From its conceptual beginnings over 25 years ago, the driving force behind writing this book has always been to provide the most thorough, up-to-date, comprehensive field guide on native amphibians and reptiles of Arkansas. This book is intended to serve as a reference source as well as an identification guide for students enrolled in a college herpetology course offered at any of our state's colleges and universities. Furthermore, we also realized early in this undertaking that the inclusion of full-color photographs of adult animals along with their juvenile and/or larval stages would make this book hold a much broader appeal to not only biologists and scientists, but also to a general public audience who often seek visual information about these fascinating creatures.

By using the illustrated identification keys, species accounts, and pictorial guides found within this book, species recognition of Arkansas's herpetofauna within their native habitats or simply in a back yard can be achieved by almost anyone. We hope the reader and user of this book will experience the enjoyment and enthusiasm shared by many who aspire to understand, appreciate, and protect the vital role of amphibians and reptiles in our natural state.

Acknowledgments

A treatise on the herpetofauna (or simply herps) of an entire state the size of Arkansas would logically be a very difficult undertaking for any single researcher or, indeed, small group of researchers such as ourselves, were it not for the enthusiastic assistance and cooperative spirit exhibited by a multitude of persons who rightfully need to be recognized for their efforts. From these dedicated individuals much important and useful data were gleaned about the systematics, biology, and distribution of Arkansas herps.

Heartfelt thanks are extended to Neil H. Douglas (Northeast Louisiana University [NLU]; now University of Northeast Louisiana) for his gracious sharing of NLU records of Arkansas herps collected by him and his many students over the years, his vast knowledge of amphibians and reptiles in general, and his wonderful hospitality shown on numerous visits by HWR to study museum specimens and to secure Arkansas distribution records of herps housed in the NLU Vertebrate Collection. A special thanks goes to Edmond J. Bacon (University of Arkansas at Monticello), who graciously shared his many records of Arkansas herps and who provided the senior author with live specimens to photograph. Betty G. Crump (Cochran) and David A. Saugey (both employed by the United States Department of Agriculture Forest Service [USFS]) assisted us in many ways. As avid field biologists, Betty and David provided numerous new locality records, especially for poorly known species; each collaborated and published with the senior author on various field and laboratory studies. Chris T. McAllister, associate professor at Texas A&M University, Texarkana, has studied Arkansas herps with the senior author for many years, having joined him on recurrent and often highly eventful field trips. As a trusted colleague for over 20 years, Chris's research contribution to this book has been immense. Larry A. Mink and J. D. Wilhide were indispensable in upgrading computer hardware and software programs; J. D. also was invaluable by accompanying the senior author on numerous field investigations. To all of these individuals, we appreciate their continued interest and support during the preparation of this book.

For supplying various literature records and miscellaneous items on particular species in Arkansas and for sharing personal unpublished research data we thank the following individuals: Edmond J. Bacon (University of Arkansas at Monticello); Randal Berry (Little Rock Zoo); Arkansas Herpetological Society; Harold Grimmett, William Shepherd, and Tom Foti of the Arkansas Natural Heritage Commission; Charles C. Carpenter (University of Oklahoma); Mike Cartwright (Arkansas Game and Fish Commission [AG&FC], Calico Rock office); James R. Dixon (Texas A&M University); Jim Dobie (Auburn University); William Duellman (University of Kansas Museum of Natural History); Harold Dundee (Tulane University); Bryan Glass (Oklahoma State University); John Iverson (Earlham College); Jim Jacob (Memphis State University); Robert Martin (University of Texas); the late C. J. McCoy (Carnegie Museum); the late Dean Metter (University of Missouri, Columbia); Max Nickerson (Florida Museum of Natural History); Ron Nussbaum (University of Michigan); Doug Reagan; James M. Walker (University of Arkansas); Kenneth Williams (Northwestern State University of Louisiana); Robert F. Wilkinson (Southwest Missouri State University); John Dempsey and students (Arkansas High School, Texarkana); Betty Busby and students (Pocahontas High School); Joy Trauth and students (Jonesboro High School); Bruce and Lana Ewing (Mena); Elvis Poe (AG&FC, Jonesboro office); James Lynn (Rich Mountain Community College); Ron Goddard and students (Waldron High School); Richard Highton (University of Maryland); Glyn Turnipseed (Arkansas Tech University); Thomas Buchanan (University of Arkansas at Fort Smith); George Oviatt (National Park Service, Buffalo National River); Gene Leeds (USDA, Forest Service); Carl D. Anthony (John Carroll University); Joseph T. Collins (University of Kansas Museum of Natural History); Laurence M. Hardy (Louisiana State University in Shreveport); Peggy R. Dorris (Henderson State University); the late Charles West (Marianna); George M. Patton and Martha A. Messinger, Bastrop, Louisiana; and Brad Holiman and Joyce Tinsley, Queen Wilhelmina State Park.

We extend our gratitude to the many museum curators in charge of herpetofaunal collections as well as personal collectors who supplied Arkansas records for us. These individuals and their institutions or museums are

David Auth (Florida Museum of Natural History), Frank Burbrink and Jeff Boundy (Louisiana State University Museum of Natural Science, Baton Rouge), Renn Tumlison (Henderson State University), Thomas Buchanan (University of Arkansas at Fort Smith, Natural History Collection), Thomas Vance (Navarro College), Veryl Board (Lyon College), Robert F. Wilkinson (Southwest Missouri State University), John L. Carr and Neil Douglas (Northeast Louisiana University), Laurence M. Hardy (Louisiana State University Museum, Shreveport, Museum of Life Sciences), Harold A. Dundee (Tulane Museum of Natural History), Ken Williams (Northwestern State University of Louisiana), Ernest A. Liner (personal collection), Darrell Heath (University of Arkansas at Little Rock), Linda S. Ford (American Museum of Natural History), William Duellman and Joseph T. Collins (University of Kansas Museum of Natural History), Robert Bezy (Los Angeles County Museum of Natural History), Laurie J. Vitt and Jan P. Caldwell (Oklahoma Museum of Natural History), Nancy McCartney (University of Arkansas Museum), Alan Resetar (Field Museum of Natural History), Edmond Bacon (University of Arkansas at Monticello), Bryan P. Glass and Richard L. Lardie (Oklahoma State University), the late Dean Metter (University of Missouri, Columbia), Robert P. Reynolds and Ron Heyer (National Museum of Natural History), Ellen Censky and the late C. J. McCoy (Carnegie Museum of Natural History), Greg Schneider (University of Michigan Museum of Zoology), Gary Casper (Milwaukee Public Museum), and Glyn Turnipseed (Arkansas Tech University).

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All color photographs were supplied by the senior author, unless otherwise stated in the photo caption. Renn Tumlison prepared the excellent line drawings of all illustrations within the identification keys; for tackling this major task, we are sincerely grateful to Renn and his immeasurable contribution to this book. Black-and-white photos are acknowledged within photo captions; we sincerely thank Mr. Fred Black of Carpinteria, California, for providing the photo of his late father. The senior author acknowledges the special assistance provided by Arkansas State University (College of Sciences and Mathematics and the Department of Biological Sciences) through the development of the Arkansas State University (ASU) herpetological collection and research facilities where over 28,000 herp specimens (mostly from Arkansas) are currently housed.

The AG&FC graciously provided funding for parts of this book through grants to the senior author; Sam Barkley, Kelly Irwin, Karen Lowe, Brian Wagner, and John Welsh (all of the AG&FC) were instrumental in securing funding for various herp research projects that enhanced the completion of this book. In addition, Brian provided an extensive list of unpublished turtle records of the AG&FC.

A personal debt of gratitude is extended by the senior author to Douglas A. James and James M. Walker (University of Arkansas at Fayetteville) for awakening a latent interest in herpetology while he was an undergraduate student. Robert H. Mount and George W. Folkerts (Auburn University), whose scientific expertise in herpetology and whose compassion for the herpetofauna of the southeastern United States, also provided a fertile ground for professional growth and discovery. And, to the many students who shall go unnamed here for their perseverance during many long and often arduous collecting trips, a sincere thank you is offered.

An interest in herpetology was initially ignited in HWR by William Byrd (Arkansas State University) during an introductory taxonomy class; the late Earl Hanebrink (also at ASU at that time) provided many useful discussions on methodologies involving the collection of herps in those early days. Thanks to Dan England, former chairman of the Southern Arkansas University (SAU) biology department, for his unfailing support and encouragement of HWR's research through all the years at SAU on herps, fishes, and other groups and to the present chairman, James Rasmussen, for continued support and encouragement. In addition, SAU provided much needed field support for this and other projects through research grants.

Inspired by Joe Collins and Max Nickerson and finding a dearth of information regarding Arkansas herps, MVP joined the Arkansas herp team soon after coming to Harding University (HU) in 1976. For support of fieldwork over the years, he thanks HU administrators Jack Wood Sears, Dean Priest, George Woodruff, John Moon, and Neale Pryor. MVP also congratulates his students from those early years who managed to succeed

despite his "desperate and pitiful" attempts at classroom teaching.

Many students from Arkansas State University provided considerable time and effort in assisting SET collecting, documenting, and cataloguing museum specimens; they include Richard Atwill, Brady Baker, Ben Ball, David Butler, Brian Butterfield, Brad Carner, Phyllis Chaffin, Kelly Cobb, Shawn Cochran, Robert L. Cox, Patrick Daniel, Denver Dunn, Doug Fletcher, Craig Hilburn, Vernon Hoffman, Anthony Holt, Brad Howerton, David Jamieson, Tracy Klotz, Rusty McAllister, Malcolm McCallum, Charles McDowell, Johnny Mclean, Walter Meshaka Jr., Steve Moulton, Bobby Neal, Walter Neasbitt, Gina Perry, Charles Reinhart, Brady Richards, John Robinette, Tim Steward, Phillip Stewart, Ben Wheeler, Scott Woolbright, and Hilary Worley. In addition, many recent records (many of them new county records from southern counties) were provided by Tobin Fulmer and Brian Caldwell (students from Henderson State University).

Former SAU students who aided in the collection of many of the herps used in this study include the following: Ken Ball, Jackie Beene, Larry Calhoun, Nick Covington, Matt Evans, John L. Harris, Bill Hoglund, Steve Pelt, Jan Rader, Lindsay Robison, Patrick Robison, and Steve Winters. Appreciation goes to Jan Rader for her meticulous reading of segments of the manuscript.

A host of Harding University herpetology students made substantive contributions over the years. Most notable among these are Britt Burcham, Brian Butterfield, Jeff Demuth, Tom Duncan, Brian Forsythe, Jim Godwin, Jo Goy, Jack Greenhaw, John Johnson, Matt May, Nathan Mills, Mike Patterson, Jody Pryor, Randy Ransom, Don Sanders, Craig and Chris Shadrix, Steve Stumne, Sharon Waldrop, and John White. Thanks to Jeff Demuth, Nathan Mills, and Rich Siegel for comments on partial drafts of the manuscript.

Finally, we offer a very special thanks to several former students, colleagues, and fellow herpetologists (Brian Butterfield, Laurence Hardy, Kelly Irwin, Walter E. Meshaka, Jr., and Joseph T. Collins) who thoroughly reviewed the unfinished draft of this manuscript and provided numerous constructive comments to improve its quality and content. Rusty McAllister helped create the "Counties of Arkansas" map shown at the back of this book. Larry Malley and Brian King of the University of Arkansas Press wrestled with the production and layout of this book. We also express our appreciation to Ellen Beeler, who devoted much time and effort formatting the text and for her thoughtful care in designing this book. In addition, Debbie Self spent many hours copyediting the text and, thereby, added greatly to its readability. To these individuals, we are also sincerely grateful. We, however, accept full responsibility for any factual errors or inadvertent mistakes retained within this book.

Introduction

Among nature's living creatures are an incredibly diverse assemblage of animals called vertebrates, who, by virtue of the presence of a series of anatomical segments (vertebrae) comprising their vertebral column ("backbone"; Fig. 1), are related to one another as well as to humans. Vertebrates have existed on earth for around 500 million years. Scientists have divided living as well as extinct vertebrates into groupings (called taxa) by categorizing them, noting common sets of morphological features that characterize each grouping. The hierarchical set of vertebrate taxa descending from the subphylum Craniata include various classes, orders, families, genera, and species. A single species often possesses a unique assortment of adaptive traits that are strikingly different from other animals or are subtly different from similar-looking animals. These adaptive traits were molded by the processes of natural selection and genetic mutation. The evolutionary past and present-day life cycles of vertebrates provide the framework for understanding our own heritage on earth.

Our traditional classification system for vertebrates, in place for more than 200 years, has established the following general groupings of vertebrate animals: jawless fishes, cartilaginous fishes, bony fishes, amphibians, reptiles, birds, and mammals. Today, however, this long-accepted system is undergoing a transformation as new morphological data obtained from the fossil record become available and/or new methods of interpreting or analyzing ancestral-descendant relationships are applied to the massive volume of available data. For instance, turtles are noted for their distinctive shells, a unique feature they do not share with any other group of tetrapods (four-footed vertebrates). This morphology, alone, could place turtles into a separate taxonomic category, possibly excluding them from what we call a reptile. The recent scientific fossil discoveries in Asia indicate that some dinosaurs possessed feathers and other salient morphological features common with birds; these lines of evidence have led some scientists to drop the class Aves (birds) altogether. Thus, vertebrate classification schemes may be surprisingly different in future scientific textbooks. Some current phylogenetic (ancestral-descendant) interpretations of the taxonomic group Reptilia demand the inclusion of birds. In this book, however, we take a more traditional and historical approach to the study of herpetology to include only the class Amphibia and the paraphyletic class Reptilia.

Regional and state field guides provide a wealth of significant scientific data for understanding local vertebrate fauna. For Arkansas, informative, contemporary books on the fishes, birds, and mammals have been available for more than a decade. An obvious omission, however, has been a book covering the biology of amphibians and reptiles. One might guess, then, that the primary impetus behind writing this treatise has been to fill this

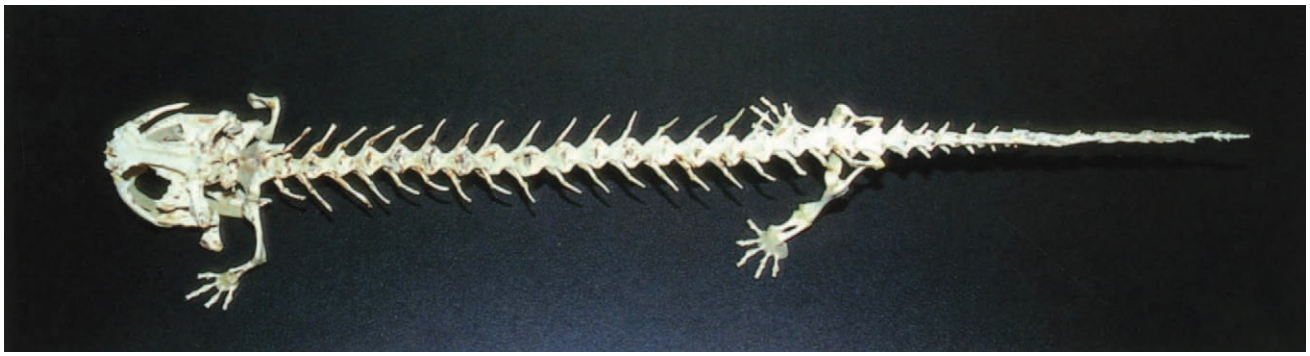


FIG. 1. Reconstructed skeleton of an Ozark hellbender *(Cryptobranchus alleganiensis bishopi)* found dead in the Spring River (Fulton County) in 1991; specimen prepared by Patrick Daniel.

noticeable void on Arkansas's vertebrates for an eagerly waiting scientific community. We surely agree, but also sincerely feel that another receptive audience may be laypersons, including both native Arkansans and visitors to this state. Furthermore, this book was designed to be a helpful educational tool to guide Arkansas high school and college students in the study of amphibians and reptiles.

This book covers the 137 species and subspecies of amphibians and reptiles that have been reported in the scientific literature to occur within the borders of Arkansas. Exotic species have been excluded from any species account, although some species can and often do establish thriving temporary or even permanent colonies in localized habitats (see **Exotic Species**). Out of convenience, we have prepared the text of this book to conform to a style reminiscent of similar state herpetofaunal guides. Specific information on the life cycle and habits of each species (or subspecies) is reviewed and discussed in a separate **Species Account**. Each account also contains a recent photograph(s) of the animal in question, information on sexual and/or geographic morphological variation (e.g., scutellation counts of snakes accompanied by ± one standard deviation), state and species-wide distributional maps, comments regarding the conservation status of the species, and a brief summary of the scientific literature pertaining to the species from research conducted within Arkansas. When no data were available on in-state species, we incorporated information on species from studies outside the state. Recent declines in amphibian species have alarmed scientists throughout the world; in order to better inform our readers as to critical habitats and life-history stages of amphibians, we have also inserted photographs of breeding habitats, courtship and mating activity, egg-laying sites, and egg clusters for many species. Some subspecies were granted a separate account (see **About Species and Subspecies**), especially when considerable data were available about that particular form within the state. Symbols on distribution maps overlap approximately a three kilometer (km) radius at the midpoint of each locality record. Each symbol also represents either a single specimen or a group of specimens taken from an individual locality. Each locality was obtained from museum vouchers and/or literature records, and we also included our personal records. Localities separated by four km or more are denoted by a separate symbol.

For this book, Trauth wrote the following parts: preface, introduction, sections on the history of Arkansas herpetology, on searching for and observing herps, on species and subspecies, on conservation (in part), and on exotic species; in addition, he provided all color photographs (unless otherwise stated), prepared the species accounts and keys to lizards and snakes, and constructed the distribution maps, pictorial guides to larval amphibians, and the indexes. Robison prepared the amphibian accounts, except for those on spadefoots, and contributed to the section on conservation (in part) and the keys to amphibians. Plummer contributed the sections on ecoregions of Arkansas, the turtle accounts, the alligator account, conservation (in part), on erroneous species, and wrote the spadefoot accounts; he also prepared the key to turtles. Each of us, however, shared in the editing of various sections and species accounts; we inspected several drafts of the entire manuscript as well as this final version.

As you begin the journey of discovery within the covers of this book, we offer this sober reminder: Humans share the natural world with an amazing and seemingly endless number and variety of organisms; the actual number of described plants and animals reaches around 1.5 million, and there are many forms (estimated to number around 100 million) which remain to be discovered deep within jungles or at the ocean's depths (Savage, 1995). For the most part, however, our westernized society requires that most people lead a rapid-paced daily existence—one that allows them more time for contact with a computer than with nature and one that largely excludes the bulk of nature's wildlife. A plethora of wild animals can be witnessed today, viewed in books, magazines, television programs, and on the Internet; yet, most people rely on zoos and botanical gardens to provide the living sanctuaries to observe, possibly touch, and, more importantly, appreciate the role played by wild species. These forums can reveal much to us about the lives of these fascinating creatures, but, unfortunately, cannot instill within us the urgency for saving natural habitats and, thus, preserving a place for their future survival. Today, our technological success threatens to alter nearly all available environments and, thus, inexorably change the conditions which have driven life processes in the past. Fortunately, we have the knowledge to avoid calamities, but historically, the fact is that humans have not had the wisdom and foresight to do much of anything in terms of prevention. They only do after-the-fact crisis management. All of us must bear the burden of making prudent choices that will affect all life.

A History of Arkansas Herpetology and Herpetofaunal Literature

Before 1900

Surprisingly little was known about the herps of Arkansas prior to 1900. The earliest contributions came from railroad survey teams which collected herps in the "Arkansas Territory," a geographic region encompassing not only Arkansas, but also the surrounding states of Missouri and Oklahoma. Their published findings (during the late 1850s) provided the first records for the state (reviewed by Vance, 1985). Hay's (1888) account on the breeding biology of *Amphiuma tridactylum* in the Little Rock area, however, marks a formal starting point for Arkansas herpetology by being the first natural history note on a herp studied within the state's border. During the 1890s, the resort city of Hot Springs became a geographic focal point for several early collections of herps. The Brimley brothers (Herbert H. and Clement S.), best known for their significant biological contributions in the state of North Carolina, are credited with sending salamanders from Hot Springs to Leonhard Stejneger, curator of herpetology at the United States National Museum. Stejneger described *Desmognathus brimleyorum* from these specimens in honor of the Brimleys (Stejneger, 1894), the first Arkansas record for *Ambystoma annulatum* came from this collection, and Brimley and Brimley (1895) also briefly described the habitat of *A. annulatum*. Bert L. Combs collected herps extensively in Hot Springs from 1894 through 1896, gathering nearly 250 specimens representing 36 species and subspecies (Strecker, 1908). Following his untimely death at the age of 20 in Iowa (and at the prior request of Combs), Combs's collection was placed into several museums and personal collections throughout the United States. Incidently, even the specimens credited to the Brimleys were actually collected by Combs (Hurter and Strecker, 1909; Strecker, 1924).

1900s

The first comprehensive list of amphibians and reptiles for Arkansas, compiled by Julius Hurter (the "father" of Missouri herpetology; see Johnson, 1987, 2000) and John K. Strecker (Hurter and Strecker, 1909), contained 90 species. They incorporated collections supplied by several individuals and localities including those made by C. J. Pierson (Fort Smith area; see McLain, 1899), Seth E. Meek (from several localities; e.g., Arkadelphia, Clarksville, Donaldson, Fayetteville, and Greenway), and the personal collection of Hurter (e.g., from Hot Springs [Combs collection], Paragould, Pine Bluff, and Texarkana). Although this list included specimens from only 15 of the 75 counties in Arkansas, it represented the first attempt to compare herp records from Arkansas with those from other states. Strecker returned to the Hot Springs area in 1923 and added nine more species to the total number recorded from Garland County (Strecker, 1924) plus one more to the list compiled by Hurter and Strecker (1909). Interestingly, Strecker was unable to find *Tropidonotus leberis (Regina septemvittata)*, a species noted as being

abundant by Combs in the Hot Springs area. (Conant [1960] examined three of the *R. septemvittata* collected by Combs [from Hurter's collection]; these specimens are currently housed in the United States National Museum.) Stone's (1903) brief report on Arkansas herps collected by Henry A. Pilsbry was the first survey to provide specimens from some of the higher elevations in Arkansas (e.g., Magazine Mountain, Petit Jean Mountain, and Sugar Loaf Mountain).

1920s and 1930s

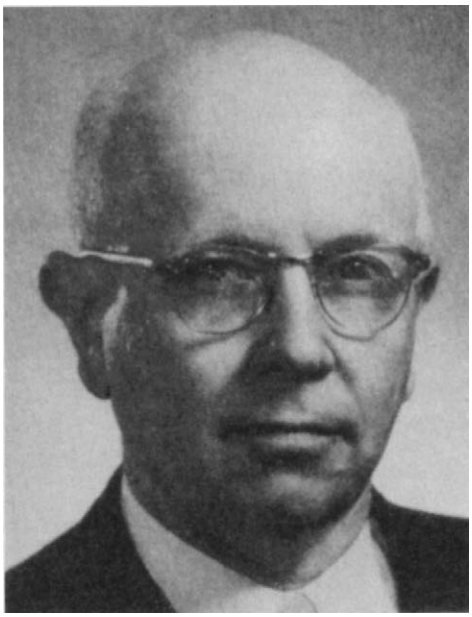
Increased herpetofaunal collecting activity occurred in the late 1920s and early 1930s in Arkansas with studies by Ortenburger (1929) and Burt and Burt (1929) providing additional county records. The first confirmed records for *Crotalus atrox* in Arkansas were reported from several localities west of Little Rock by Marlin Perkins and Moody Lentz (Perkins, 1928; Perkins and Lentz, 1932). *Plethodon ouachitae,* the first among several endemic Ouachita Mountains' salamanders that would eventually be described, was collected on Rich Mountain (Polk County) by Dunn and Heinze (1933). The first verifiable record for *Eurycea quadridigitata* in Arkansas was reported by Smith (1933) near Lewisville (Lafayette County). Likewise, Black (1933) published the first record for *Rana sylvatica* (Washington County) and followed this with an additional record from Franklin County (Black, 1938). Field studies by Noble and Marshall (1929, 1932) provided new data on the breeding activity of *Ambystoma annulatum* and *Siren intermedia.*

By the mid-1930s substantial numbers of Arkansas herps had already been deposited in most major museum and university research collections across the United States. (For example, Arkansas specimens were utilized by Blanchard [1921, 1924] in his examination of geographic variation in *Lampropeltis* and *Carphophis,* respectively.) Moreover, in some cases, a wealth of locality data acquired during field expeditions was published by some collectors. For instance, Edward H. Taylor's account (Taylor, 1935) on herps from DeValls Bluff (Prairie County), Lewisville (Lafayette County), and Imboden (Lawrence County) also included comments on Arkansas specimens collected from other localities which had been placed in the University of Kansas Museum over a ten-year period (1926–1935). Charles E. Burt returned to Arkansas in 1934 to conduct additional collecting as part of a multi-state survey funded by the Smithsonian Institution. His published account (Burt, 1935) represented the most extensive, statewide survey conducted to that time; specimens were deposited in the United States National Museum. Smith (1937) utilized *Scaphiopus holbrookii hurterii* provided by several Arkansas collectors for an osteological examination on the subspecies of this anuran.

Three major contributions to our understanding of the natural history and distribution of Arkansas herps appeared in 1938. Two of these (Dellinger and Black, 1938; Schwardt, 1938) highlighted reptiles; all three authors were affiliated with the University of Arkansas (Fig. 2). Schwardt's work provided descriptions (many with photographs) and general accounts on nearly all species known to occur within the state, updated county records, and, most significantly, incorporated the first illustrated key to Arkansas snakes. The paper by Dellinger and Black complemented Schwardt's reptilian accounts by listing locality records on 83 reptiles; the collection data were gleaned from many major institutional collections as well as from private collectors. Several notable species not currently accepted as occurring naturally in the state were included in this comprehensive work (i.e., *Sceloporus olivaceus, Eumeces brevilineatus, Leptotyphlops dulcis, Liopeltis vernalis,* and *Tropidoclonion lineatum*). The amphibian paper by Black and Dellinger (1938) was similar in style and format to its reptilian counterpart. Species included in this publication, such as *Amphiuma means, Ambystoma jeffersonianum, Siren lacertina, Bufo terrestris,* and *Hyla femoralis,* are no longer considered valid Arkansas records. As the decade ended, Moore and Hughes (1939) had described *Eurycea tynerensis* from eastern Oklahoma (a neotenic plethodontid salamander known in Arkansas only from the extreme northwestern corner of the state).

1940s

Although interest in herpetology waned during and immediately following World War II, several studies contributed to an understanding of herps within the Delta region of eastern Arkansas. Goin (1942) described a new race of siren *(Siren intermedia nettingi)* from Imboden (Lawrence County). Parker (1947) and Minton and Minton (1948) conducted herpetofaunal surveys in Clay, Greene, and Mississippi counties. Parker assigned the records for *Hyla squirella* collected by Meek near Greenway (as reported by Hurter and Strecker, 1909) as *Pseudacris ornata* (= *P. streckeri illinoensis*). Parker also revised the species lists and specific distributional records of Hurter and Strecker (1909), Black and Dellinger (1938), and Schwardt (1938) so as to conform with prevailing nomenclature of that time. By the late 1940s, Arkansas continued to be a source of herpetological information for researchers traveling through the state. Burger et al. (1949) found *Scaphiopus hurterii* from Calion (Union County),



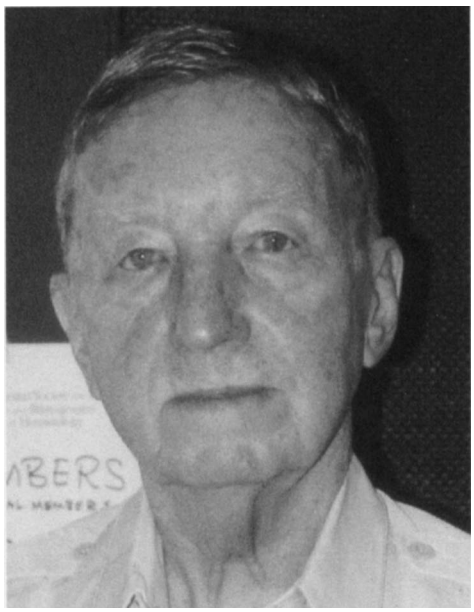


FIG. 2. Photos (clockwise from upper left corner): Samuel C. Dellinger (courtesy of the Special Collections Division, University of Arkansas Libraries), John D. Black (courtesy of Fred Black, Carpinteria, California), Herndon G. Dowling (July 2002; photo by S. E. Trauth), and Herbert H. Schwardt (reprinted with permission of Rutgers University Press).

and Smith and Langebartel (1949) reported finding a single specimen of *Bufo valliceps* (= *B. nebulifer*) from Calion. The latter represents the only Arkansas record for this species. Chaney (1949) investigated the life history of *Desmognathus fuscus* in southern Arkansas.

1950s

Even as the 1950s marked a shift away from specimen collecting and a movement toward ecological studies (e.g., studies by Pope and Pope [1951] on *Plethodon ouachitae* and Trapp [1956, 1959] on *Ambystoma annulatum*), the Ouachita Mountains of Arkansas remained a prime region for systematic investigations on plethodontid salamanders. For example, while studying *Plethodon ouachitae,* Pope and Pope (1951) described *Plethodon caddoensis,* an endemic Arkansas salamander of the *ouachitae* group, from the Caddo Mountains. Additional salamanders of the plethodontid genus *Desmognathus* were investigated in Arkansas by Grobman (1950), Chaney (1958), and Rossman (1958); those of the genus *Eurycea* were studied by Dundee (1958). Malewitz (1956) published on intestinal parasites in *Cryptobranchus alleganiensis bishopi* from the Spring River (Fulton County).

While a professor at the University of Arkansas at Fayetteville, Herndon G. Dowling (Fig. 2) published two

significant papers (1956, 1957) on Arkansas herpetology. The former study examined present-day distributions of endemic salamanders within the Interior Highland region and correlated herpetofaunal invasions into this region through geologic time. He also recognized four herpetofaunal immigrations that reflected the current geographic ranges of several Arkansas herps (e.g., *Rana sylvatica* from the north, *Crotaphytus collaris* from the southwest, *Eurycea longicauda* from the east, and *Agkistrodon piscivorus* from the southeast). By far, Dowling's singularly most important contribution appeared in 1957 with the publication of "A Review of the Amphibians and Reptiles of Arkansas." This comprehensive (at that time), contemporary account of Arkansas herpetofauna and literature was primarily a continuation of the format and style of Dellinger and Black (1938) and Black and Dellinger (1938). Dowling did, however, address problematic species by reevaluating old records and updating scientific names, ranges, and county records; he also provided new information on species known in the state that had accumulated over a 20-year span since the 1938 publications. By this time, a total of 95 species was included in this work (21 salamanders, 17 anurans, 8 lizards, 34 snakes, 14 turtles, and 1 alligator). Dowling (1958) also reported the only records for the ground snake in Arkansas.

1960s

Studies on plethodontid salamanders dominated the herpetological literature in Arkansas during the 1960s, with the notable exception of another report on *Cryptobranchus alleganiensis bishopi* from the Spring River by Dundee and Dundee (1965). In a follow-up study to Dundee's dissertation (1958) on *Eurycea,* Fogle (1960) investigated the life history of *E. multiplicata griseogaster* in the Fayetteville area for a master's thesis (University of Arkansas). Several studies on *Typhlotriton spelaeus* (Smith, 1959, 1968) generated controversy regarding the monotypic status of this species. While a faculty member at Arkansas (Lyon) College, Smith suggested the occurrence of a neotenic form of *Typhlotriton (T. braggi)* at Cushman (Blowing) Cave in the Batesville area (Independence County). Brandon and Black (1970), however, discussed the lack of distinctive features of *T. braggi* and placed it in synonymy with *T. spelaeus.* In another study at Blowing Cave, Smith (1964) made observations on hybridization between *Eurycea lucifuga* and *Eurycea longicauda melanopleura.* Smith (1960) also examined Arkansas populations of *Desmognathus* and compared them to specimens collected in other states; his 11 samples included 600 specimens of these salamanders! Of particular interest in Smith's report was his collection of *Desmognathus* at Flippin (Marion County) and his support of claims by Grobman (1950) and Bishop (1943) that *Desmognathus* occurred in Eureka Springs (Carroll County) and Walnut Ridge (Lawrence County). In his monograph on *Desmognathus,* Means (1974) neither discusses these localities nor makes literature references to Grobman or Smith; no specimens of this genus have been reported from the Flippin or Eureka Springs areas following Smith's work. In another study Blair and Lindsay (1965) discussed the color variations in *Plethodon* from the Ouachita Mountains. Easterla (1968) reported melanistic *Ambystoma maculatum* from northeastern Arkansas.

Two species with disjunct distributions in Arkansas *(Regina septemvittata* and *Hemidactylium scutatum)* were discussed by Conant (1960) and Dundee (1968), respectively. Conant reported the lack of specimens of *R. septemvittata* from Hot Springs following the Combs collection; his study also examined disjunctions in the ranges of various plethodontid salamanders inhabiting the Interior Highlands. Dundee suggested that *H. scutatum* had a limited association with sphagnum moss and was scarce in Arkansas; this was countered by a later study (Saugey and Trauth, 1991) which indicated that the species was more common than previously understood and that it utilized mossy areas as primary egg deposition sites.

1970s

Herpetological research and publications increased dramatically in the 1970s as field and laboratory studies became the primary research interests of several graduate students at the University of Arkansas at Fayetteville. Under the guidance of Drs. James M. Walker, John. A. Sealander, and the late James H. Quinn, a number of theses and dissertations provided significant contributions to an understanding of Arkansas herpetology; included among these were various herp topics (followed by student and year of completion): snake physiology (Elick, 1970), salamander physiology (Spotila, 1970), systematics and reproduction in *Eurycea multiplicata* (Ireland, 1971), ecology of *Terrapene carolina* (Reagan, 1972), population structure and reproduction in *Sceloporus undulatus* (Arnett, 1972), herpetofauna of Peccary Cave (Davis, 1973), cranial osteology and myology of *Opheodrys aestivus* (Cundall, 1974), demography and reproduction in *Crotaphytus collaris* (Trauth, 1974), and parasites of *Eurycea* (Saltarelli, 1977). Barnett (1970) completed a master's thesis (Northwestern State University, Natchitoches, Louisiana) on cave populations of salamanders from Randolph County, and Wortham (1970) examined

protein serums in *Cryptobranchus* (Arkansas State University, Jonesboro). Many of these students published all or parts of their graduate research, or they produced other papers during this decade: Spotila (1972)—thermal and water requirements in plethodontids; Spotila and Beumer (1970)—breeding habits of *Ambystoma annulatum;* Spotila and Ireland (1970)—eggs of *Eurycea multiplicata griseogaster;* Ireland (1973)—overwintering of *Ambystoma maculatum* larvae; Ireland (1974)—reproduction in *Eurycea longicauda melanopleura;* Ireland (1976)—reproduction in *E. m. griseogaster;* Reagan (1974c)—habitat selection in *Terrapene carolina triunguis;* Trauth (1978, 1979)—reproduction in *Crotaphytus collaris;* and Trauth (1977)—winter collection of eggs in *Cnemidophorus sexlineatus.*

Besides Reagan's work on *T. carolina,* additional studies examined turtle biology. There were investigations on feeding habits of *Graptemys pseudogeographica ouachitensis* (Moll, 1976), systematics of *Graptemys pseudogeographica* (Vogt, 1978), and reproduction in *Kinosternon subrubrum* (Iverson, 1979b). Several papers appeared on *Cemophora coccinea* (Byrd and Hanebrink, 1976, 1978; Sutton and McDaniel, 1979) and on the physiology of several colubrid snake species (Baeyens et al., 1978, 1979). Four papers continued to address *Desmognathus* (Cook and Brown, 1974; Means, 1974; Wortham et al., 1977; Nickerson et al., 1979). In addition, Nickerson and Mays (1973a) published their seminal work on *Cryptobranchus,* which later inspired work by Peterson and his colleagues on Spring River populations in the 1980s. Highton and Webster (1976) clarified the genetic status of *Plethodon serratus* (formerly *P. cinereus*). Wortham et al. (1977) also examined the sperm morphology in *Eurycea lucifuga* and *Plethodon serratus.* Robison and Douglas (1979) reported the first records for *Eumeces obsoletus* in Arkansas; Bacon and Anderson (1976) provided new county records for several herps within the Gulf Coastal Plain. Brown (1974) and Rosen and Manis (1976) reported on the food habits and trematode parasites, respectively, of selected anurans from Arkansas. Schuier et al. (1972) published important records on the herpetofauna of Ozark National Forest; among these were new localities for *Rana sylvatica* and *Scaphiopus holbrookii hurterii* in Stone County. McKamie and Heidt (1974) examined the food habits of *Rana catesbeiana* from central Arkansas. The herps of Ozark caves was reported on by McDaniel and Gardner (1977). A significant herpetological discovery within Arkansas in the 1970s was the description of *Plethodon fourchensis,* the second endemic plethodontid salamander found in the Ouachita Mountains of Arkansas (Duncan and Highton, 1979).

1980s

Investigations on Arkansas's herpetofauna in the 1980s added nearly as many papers to the herpetological literature of Arkansas as all previous years combined. Graduate research in the form of theses and dissertations continued to flow out of several universities with contributions from Arkansas State University (McAllister, 1980a—ecology of *Crotaphytus collaris;* Butterfield, 1988—biology of *Pseudacris streckeri illinoensis;* Meshaka, 1988b—biology of *Plethodon dorsalis angusticlavius = P. angusticlavius*), Henderson State University (Ball, 1980—herpetofauna of the Red River region), Northeast Louisiana University (Albritton, 1981—herpetofauna of Bradley County; Martin, 1981—herpetofauna of Polk County), and the University of Arkansas at Fayetteville (Bonati, 1980—herpetofauna of northwest Arkansas; Durham, 1980—behavior in *Heterodon platirhinos;* Paulissen, 1981—microhabitat selection in *Cnemidophorus sexlineatus;* Kuss, 1986—habitat utilization in *Plethodon;* Britton, 1986—microhabitat utilization as feeding niches in *Plethodon dorsalis angusticlavius* and *Plethodon glutinosus*). The results of Michael V. Plummer's long-term field investigation on the population ecology of *Opheodrys aestivus* at Bald Knob Lake (1978–1985) and Ransom Lake (1986–1992)—both in White County—were beginning to appear in a series of publications (Dove et al., 1982; Plummer, 1980a, 1981a, b; 1983, 1984, 1985a, b; 1989; Plummer and Snell, 1988). These in-depth papers documented a plethora of new life-history information on this species, making this snake one of the most thoroughly studied ecologically and best-known colubrids in the United States.

Major contributions to an understanding of the biology of *Cryptobranchus alleganiensis* (Spring River populations) also occurred during this decade; these works arose mostly out of a dissertation by Chris L. Peterson (1985, University of Missouri, Columbia). Peterson and/or his colleagues addressed demography (Peterson et al., 1988), food habits (Peterson et al., 1989b), and reproduction (Topping and Ingersol, 1981; Peterson et al., 1989a) in this salamander.

Two identification keys, one on larval salamanders and the other on reptiles (Ireland and Altig, 1982; Vance, 1982b), provided assistance in distinguishing specimens from Arkansas. Three studies examined salamander use of abandoned mine shafts in the Ouachita Mountains (Heath et al., 1986; Saugey et al., 1985, 1988), two other studies reported on the biology and/or the morphological distinctiveness of *Eurycea tynerensis* (Cline et al., 1989; Tumlison et al., 1989), and Sugg et al. (1988) reported

on morphological variation in *Siren intermedia nettingi* from Pulaski County. Another study by McAllister and Fitzpatrick (1985) examined oxygen consumption in *Eurycea multiplicata griseogaster.* Tumlison and Gann (1988) reported on the distribution of *Coluber constrictor anthicus* in southern Arkansas. The work by Highton et al. (1989) further clarified relationships among the *Plethodon glutinosus* complex (with *P. albagula* replacing *P. glutinosus; P. kiamichi, P. kisatchie,* and *P. sequoyah* were designated as new species in Arkansas). Brussock and Brown (1982) elaborated on selection of breeding ponds by *Ambystoma annulatum.*

Mullen et al. (1984) reported the first Arkansas record of dipteran parasitism on eggs of *Sceloporus undulatus* from Petit Jean Mountain (Conway County), and a study by Winter et al. (1986) dealt with parasites of plethodontid salamanders of the Ouachita Mountains. Studies by McAllister (1980b, 1983) examined ectoparasites and aquatic behavior in *Crotaphytus collaris,* respectively; collaboration by McAllister and Trauth also resulted in additional papers on this species (McAllister and Trauth, 1982, 1985; McAllister et al., 1985); Trauth (1989a) also surveyed this lizard in the Arkansas Valley. In another lizard study, Trauth (1984b) reported on the seasonal activity and reproduction in *Ophisaurus attenuatus.* Although his dissertation work emphasized geographic variation in *Cnemidophorus sexlineatus* throughout its range (Trauth, 1980), many of Trauth's specimens were collected over much of Arkansas (a region of subspecific intergradation between *C. s. sexlineatus* and *C. s. viridis*). A study on the nesting habits and reproduction in this species focused on Arkansas localities (Trauth, 1983b).

Trauth's studies on Arkansas's herpetofauna accelerated upon his arrival at Arkansas State University in 1984. His publications resulted from research conducted primarily on herps within Arkansas's borders; collaborative works with several students as well as with colleagues added new information on a variety of Arkansas species. For example, there were additional studies on *Cnemidophorus sexlineatus* including papers on the embryonic egg tooth (Trauth, 1988i) and eggshell morphology (Trauth and Fagerberg, 1984) using electron microscopy. Chaffin and Trauth (1987) examined toe tip morphology of the *Hyla chrysoscelis/Hyla versicolor* complex throughout the state using scanning electron microscopy. Also investigated was reproduction in two ambystomatid salamanders —*Ambystoma annulatum* (Trauth et al., 1989b) and *A. opacum* (Trauth et al., 1989d), in two ranid frogs—*Rana sylvatica* (Trauth et al., 1989c) and *R. sphenocephala* (Trauth, 1989b), and in *Desmognathus brimleyorum* (i.e., observation of egg clutches—Trauth, 1988). Additional studies on *Ambystoma* reported an albino larva of *A. annulatum* from Stone County (Trauth and Cartwright, 1989) and an unusual color morph of *A. opacum* from Craighead County (Trauth and Richards, 1988). Scanning electron microscopy was also used to examine dentition in *Plethodon* (Atwill and Trauth, 1988) and the toe tips of *Ambystoma* (Trauth and Wilhide, 1988). Another study on *Ambystoma* involved predation on *A. maculatum* by *Heterodon platirhinos* (Trauth, 1982a). While completing their master's theses at Arkansas State University, Brian P. Butterfield and Walter E. Meshaka coauthored studies with Trauth on *Agkistrodon contortrix* (Meshaka et al., 1989), *Eumeces laticeps* (Meshaka et al., 1988a), *Elaphe obsoleta* (Meshaka et al., 1988b), and *Pseudacris streckeri illinoensis* (Butterfield et al., 1989).

1990s

The considerable number of papers during the early 1990s that addressed endoparasites in Arkansas's herps was due, in part, to further collaboration between McAllister and Trauth (in conjunction with other colleagues). For example, McAllister first-authored 17 of these studies (1990–1995); S. J. Upton produced 9 bearing his name first (1991–1995); and D. S. Lindsay prepared 2 (1991–1992). New species of coccidian parasites were described in many of these works (for the herp species involved, see references by these authors in the **Literature Cited**). Trauth and Mullen (1990) reported a second Arkansas locality for sarcophagid fly infestation of eggs in *Sceloporus undulatus* (near Ravenden Springs, Randolph County). Vertebrate fauna in abandoned mines in the Ozarks were documented by McAllister et al. (1995).

Information on the biology of a few poorly known/rare species in Arkansas were also addressed by Trauth (or in collaboration with colleagues); these included papers on *Ambystoma talpoideum* (Trauth et al., 1993a, 1995b), *Crotalus atrox* (Trauth and Cochran, 1992), *Hemidactylium scutatum* (Saugey and Trauth, 1991; Trauth and Cochran, 1991), *Hyla avivoca* (Trauth and Robinette, 1990; Trauth, 1992), *Nerodia cyclopion* (Trauth, 1990), and *Regina septemvittata* (Trauth, 1991a). The first state record for *Rana blairi* was observed in Mississippi County (Trauth et al., 1992a). Selected new county records also appeared in Tumlison et al. (1992). Declines in Spring River populations of *Cryptobranchus alleganiensis bishopi* were addressed in Trauth et al. (1992b, 1993c). Moreover, using mtDNA variation data, Routman (1993) and Routman et al. (1994) revealed that *C. alleganiensis bishopi* in the Eleven Point and Current rivers are different from those in the Spring River. Papers by Trauth (1996,

1997, respectively) reported on the subspecies of *Diadophis punctatus* and on the first records for *Coluber constrictor latrunculus* in the state. Fletcher et al. (1992) provided distribution records for *Plethodon serratus* from the Ouachita Mountains.

Numerous papers dealing with the reproductive biology, traits, and/or structures of various herp species also appeared in the literature. While Plummer continued to publish on selected aspects of the biology of *Opheodrys aestivus* (1990a, b; 1991, 1993, 1997a, b), he also examined reproduction in female *Nerodia rhombifer* (Plummer, 1992). Trauth et al. (1994) addressed snake reproduction in 27 species. Robinette and Trauth (1992) reported on the reproductive cycle in *Farancia abacura reinwardtii.* Trauth (1994) compared the reproductive cycles of two skinks *(Eumeces fasciatus* and *E. anthracinus).* Two studies reported on reproductive characteristics of plethodontid salamanders in the Ouachita Mountains (Taylor et al., 1990; Trauth et al., 1990); the former focused mostly on comparing reproduction in *Plethodon* species, whereas the latter paper detailed reproductive traits in salamanders as well as a variety of anuran species. Meshaka and Trauth (1994) published on the reproductive cycle in *Plethodon dorsalis angusticlavius* (= *P. angusticlavius*) from northern Arkansas. Trauth and Holt (1993) observed breeding activity in *Scaphiopus holbrookii hurterii* near Dardanelle (Yell County). Trauth et al. (1995b) reported on egg masses in metamorphic *Ambystoma talpoideum* from Greene County.

Morphological studies were also conducted during this decade. Sever and Trauth (1990) reported on the cloacal anatomy of female *Desmognathus brimleyorum.* Trauth et al. (1993b) described the caudal courtship glands in *Eurycea longicauda melanopleura.* Newton and Trauth (1992) and Trauth and Buchanan (1997) examined spermatozoa of *Cnemidophorus sexlineatus.* Trauth (1991b, 1993) reported on the enlarged maxillary teeth in *Tantilla gracilis* and *Cemophora coccinea,* respectively, using scanning electron microscopy. Chen (1991) examined eggshell ultrastructure in *Scincella lateralis.* Anthony et al. (1994) examined structural damage to the nasolabial groove in *Plethodon caddoensis* and *P. ouachitae* caused by chiggers. Sever (1994) examined the cloacal anatomy of *P. ouachitae* from Polk County specimens. Conlon et al. (1997) characterized insulin of *Siren intermedia* from specimens collected in Craighead County.

Trauth et al. (1995a) reviewed the distribution and life history of *Rana sylvatica* in northcentral Arkansas, whereas two studies by Tumlison et al. (1990a, b) examined the ecological requirements of *Eurycea tynerensis.* Another study reported on the population structure in *Desmognathus brimleyorum* (Karlin et al., 1993). Aggressive behavior in *Plethodon* species was examined by Anthony (1993, 1995) and Anthony et al. (1997). Food habits were reported for *Hyla avivoca* (Jamieson et al., 1993), *Scaphiopus holbrookii* (Jamieson and Trauth, 1996), and for several species of snakes (Trauth and McAllister, 1995). Caster et al. (1995) observed herp use of nest boxes in the Ouachita Mountains, whereas Cobb and Summerhill (1996) investigated squamate species diversity in Hot Spring County. Trauth et al. (1996) observed swimming behavior in *Cnemidophorus sexlineatus* from Saline County. In addition, two behavioral studies on *Heterodon platirhinos* were published by Plummer (1996a) and Plummer and Mills (1996) on research conducted near Searcy (White County). Another paper by Plummer (1996b) associated mortality with prolonged egg retention in *H. platirhinos.*

Several studies have contributed to our knowledge of turtle biology. A concern by the AG&FC about the population status of *Macroclemys* (= *Macrochelys*) *temminckii* led to a statewide prohibition on its collection (Buhlmann, 1993); in follow-up reports, Wagner et al. (1996) provided information on its distribution and current status, and Trauth et al. (1998) reported on population structure and movements in three creeks located in Independence and Jackson counties. Three other studies investigated softshell turtles: Plummer and Burnley (1997) and Plummer et al. (1997) examined *Trionyx spiniferus* (= *Apalone spinifera*) populations near Searcy (White County), and Trauth and Worley (1997) used skeletochronology to study age in this species.

Studies published during the late 1990s dealt with a variety of herps. Verrell (1997) examined courtship behavior in *Desmognathus brimleyorum.* Cartwright et al. (1998) reported on the use of wildlife ponds by wood frogs *(Rana sylvatica)* in the Ozark National Forest of northcentral Arkansas. Hamlett et al. (1998) examined the caudal courtship glands in cave salamanders *(Eurycea lucifuga).* Ransom and Plummer (1999) studied the diel activity of a population of six-lined racerunners *(Cnemidophorus sexlineatus)* in Searcy. Trauth and Wilhide (1999) reported on the status of three plethodontid species (genus *Plethodon*) in the Ouachita National Forest in southwestern Arkansas, whereas Trauth et al. (1999) examined the reproductive biology of *Gastrophryne carolinensis* from northeastern Arkansas.

2000s

As we enter the new millennium, several recent investigations have dealt with new facets of the biology of many

Arkansas herps that have been well studied in the past. Included here are papers on the ecology of *Heterodon platirhinos* (Plummer, 1999–2000; Plummer and Mills, 2000; Plummer, 2002), winter breeding in *Ambystoma annulatum* (Trauth, 2000), nocturnal climbing activity in plethodontid salamanders (Trauth et al., 2000a), breeding mortality (Trauth et al., 2000b), death feigning (McCallum et al., 2003a), and phonotactic stalking (McCallum et al., 2003b) in *Rana sylvatica.* An unusual tail abnormality in *Macroclemys temminckii* hatchlings was the topic of another study (McCallum and Trauth, 2000). Beaupre and Roberts (2001) reported finding *Agkistrodon contortrix* feeding opportunistically on cicadas in Madison County. Beaupre and Zaidan (2001) examined CO_2 production in timber rattlesnakes from northwestern Arkansas. Zaidan (2001) examined sexual dimorphism in *Agkistrodon piscivorus leucostoma,* and Cundall and Beaupre (2001) recorded predatory strikes in *Crotalus horridus;* both of these pitviper studies were also conducted in northwestern Arkansas. Tumlison and Rocconi (2000) found specimens of the eastern box turtle, *Terrapene carolina carolina,* in southeastern Arkansas, and Iverson (2001) examined reproduction in *Pseudemys concinna.* McCallum and Trauth (2001a, b) reported on the terrestrial feeding behavior and tadpole cannibalism, respectively, in *Pseudacris streckeri illinoensis;* McCallum et al. (2003c) observed satellite behavior in this species. Prather and Briggler (2001) noted the use of caves by anurans in the Ozark Mountains. Jamieson et al. (2001) provided data on the food habits of *Desmognathus brimleyorum.* Cline and Tumlison (2001) provided locality records for *Eurycea tynerensis* from Benton County. An instance of winter predation on *Thamnophis sirtalis* by red-tailed hawks was reported by Trauth and Klotz (2002). Nagle et al. (2003) examined embryo growth and hatchling lipid reserves in *Apalone mutica.*

The most recent studies on *Cryptobranchus alleganiensis bishopi* document population declines (Wheeler et al., 2003), abnormalities (Wheeler et al., 2002), and the presence of tumors (Harshbarger and Trauth, 2002; Trauth et al., 2002). Abnormalities in *Acris crepitans* were also recently reported by McCallum and Trauth (in press). McCallum et al. (2003d) reported for the first time in Arkansas a branchiate adult *Notophthalmus viridescens louisianensis* from Randolph County. McAllister et al. (2002) summarized the parasites of four endemic salamanders in the genus *Plethodon* from the Ouachita Mountains of Arkansas and Oklahoma. Trauth et al. (2002) reported on the brooding postures and nest site fidelity in *Plethodon albagula* from an abandoned mine shaft in Garland County. Watt et al. (2002) examined the distribution of the American alligator *(Alligator mississippiensis)* in Arkansas.

(ADDENDUM: Two unexpected and significant salamander discoveries occurred in late October, 2003, just prior to this manuscript going to press. The first was the collection of a single specimen of an Ozark hellbender, *Cryptobranchus alleganiensis bishopi,* below Lock & Dam #1 on the White River at Batesville [Independence County]. This finding, only the second for the White River, will undoubtedly lead to a reexamination of the range of this species within this drainage. The second was the discovery of a striving population of dusky salamanders in the Spavinaw Creek drainage of Benton County. This find adds fuel to the question as to whether any of the unverifiable records for *Desmognathus* in northern Arkansas, as reported by Smith [1960], were actually authentic.)

Classification and Species Checklist for the Amphibians and Reptiles of Arkansas

Class Amphibia

ORDER CAUDATA—SALAMANDERS

Suborder Cryptobranchoidea

Family Cryptobranchidae—Hellbenders

Ozark Hellbender (p. 56)	*Cryptobranchus alleganiensis bishopi* Grobman, 1943

Suborder Salamandroidea

Family Ambystomatidae—Mole Salamanders

Ringed Salamander (p. 59)	*Ambystoma annulatum* Cope, 1886
Spotted Salamander (p. 61)	*Ambystoma maculatum* (Shaw, 1802)
Marbled Salamander (p. 63)	*Ambystoma opacum* (Gravenhorst, 1807)
Mole Salamander (p. 65)	*Ambystoma talpoideum* (Holbrook, 1838)
Smallmouth Salamander (p. 67)	*Ambystoma texanum* (Matthes, 1855)
Eastern Tiger Salamander (p. 68)	*Ambystoma tigrinum tigrinum* (Green, 1825)

Family Amphiumidae—Amphiumas

Three-toed Amphiuma (p. 71)	*Amphiuma tridactylum* Cuvier, 1827

Family Plethodontidae—Lungless Salamanders

Subfamily Desmognathinae (Dusky Salamanders)

Ouachita Dusky Salamander (p. 73)	*Desmognathus brimleyorum* Stejneger, 1894
Spotted Dusky Salamander (p. 75)	*Desmognathus conanti* Rossman, 1958

Subfamily Plethodontinae (Brook, Woodland, and Cave Salamanders)

Dark-sided Salamander (p. 76)	*Eurycea longicauda melanopleura* (Cope, 1893)
Cave Salamander (p. 79)	*Eurycea lucifuga* Rafinesque, 1822
Graybelly Salamander (p. 81)	*Eurycea multiplicata griseogaster* Moore and Hughes, 1941
Many-ribbed Salamander (p. 83)	*Eurycea multiplicata multiplicata* (Cope, 1869)
Dwarf Salamander (p. 84)	*Eurycea quadridigitata* (Holbrook, 1842)
Oklahoma Salamander (p. 86)	*Eurycea tynerensis* Moore and Hughes, 1939
Four-toed Salamander (p. 88)	*Hemidactylium scutatum* (Schlegel, 1838)
Western Slimy Salamander (p. 90)	*Plethodon albagula* Grobman, 1944
Ozark Zigzag Salamander (p. 92)	*Plethodon angusticlavius* Grobman, 1944
Caddo Mountain Salamander (p. 94)	*Plethodon caddoensis* Pope and Pope, 1951
Fourche Mountain Salamander (p. 96)	*Plethodon fourchensis* Duncan and Highton, 1979
Kiamichi Slimy Salamander (p. 98)	*Plethodon kiamichi* Highton, 1989
Louisiana Slimy Salamander (p. 99)	*Plethodon kisatchie* Highton, 1989
Rich Mountain Salamander (p. 99)	*Plethodon ouachitae* Dunn and Heinze, 1933
Sequoyah Slimy Salamander (p. 101)	*Plethodon sequoyah* Highton, 1989
Southern Redback Salamander (p. 102)	*Plethodon serratus* Grobman, 1944
Grotto Salamander (p. 104)	*Typhlotriton spelaeus* Stejneger, 1893

Family Proteidae—Waterdogs and Mudpuppies

Red River Mudpuppy (p. 105)	*Necturus maculosus louisianensis* Viosca, 1938

Family Salamandridae—Eastern Newts

Central Newt (p. 107)	*Notophthalmus viridescens louisianensis* Wolterstorff, 1914

Suborder Sirenoidea

Family Sirenidae—Sirens

Western Lesser Siren (p. 110)	*Siren intermedia nettingi* Goin, 1942

ORDER ANURA—FROGS AND TOADS

Family Bufonidae—True Toads

Dwarf American Toad (p. 139)	*Bufo americanus charlesmithi* Bragg, 1954
Fowler's Toad (p. 140)	*Bufo fowleri* Hinckley, 1882
Coastal Plain Toad (p. 142)	*Bufo nebulifer* Mulcahy and Mendelson, 2000
Woodhouse's Toad (p. 142)	*Bufo woodhousii* Girard, 1854

Family Hylidae—Cricket Frogs, Treefrogs, Chorus Frogs

Blanchard's Cricket Frog (p. 144)	*Acris crepitans blanchardi* Harper, 1947
Northern Cricket Frog (p. 146)	*Acris crepitans crepitans* Baird, 1854
Bird-voiced Treefrog (p. 147)	*Hyla avivoca* Viosca, 1928
Cope's Gray Treefrog; Gray Treefrog complex (p. 149)	*Hyla chrysoscelis* Cope, 1880 /*Hyla versicolor* Le Conte, 1825
Green Treefrog (p. 151)	*Hyla cinerea* (Schneider, 1799)
Northern Spring Peeper (p. 152)	*Pseudacris crucifer crucifer* (Wied-Neuwied, 1838)
Illinois Chorus Frog (p. 154)	*Pseudacris streckeri illinoensis* Smith, 1951
Strecker's Chorus Frog (p. 156)	*Pseudacris streckeri streckeri* A. A. Wright and A. H. Wright, 1933
Upland Chorus Frog (p. 157)	*Pseudacris triseriata feriarum* (Baird, 1854)
Western Chorus Frog (p. 157)	*Pseudacris triseriata triseriata* (Wied-Neuwied, 1838)

Family Microhylidae—Narrowmouth Toads

Eastern Narrowmouth Toad (p. 159)	*Gastrophryne carolinensis* (Holbrook, 1836)
Great Plains Narrowmouth Toad (p. 161)	*Gastrophryne olivacea* (Hallowell, 1857)

Family Pelobatidae—Spadefoots

Eastern Spadefoot (p. 162)	*Scaphiopus holbrookii holbrookii* (Harlan, 1835)
Hurter's Spadefoot (p. 162)	*Scaphiopus holbrookii hurterii* Strecker, 1910
Plains Spadefoot (p. 164)	*Spea bombifrons* (Cope, 1863)

Family Ranidae—True Frogs

Southern Crawfish Frog (p. 166)	*Rana areolata areolata* Baird and Girard, 1852
Northern Crawfish Frog (p. 166)	*Rana areolata circulosa* Rice and Davis, 1878
Plains Leopard Frog (p. 167)	*Rana blairi* Mecham, Littlejohn, Oldham, Brown and Brown, 1973
American Bullfrog (p. 169)	*Rana catesbeiana* Shaw, 1802
Bronze Frog (p. 171)	*Rana clamitans clamitans* Latreille, 1801
Northern Green Frog (p. 171)	*Rana clamitans melanota* Rafinesque, 1820
Pickerel Frog (p. 173)	*Rana palustris* LeConte, 1825
Southern Leopard Frog (p. 175)	*Rana sphenocephala* Cope, 1886
Wood Frog (p. 177)	*Rana sylvatica* LeConte, 1825

Class Reptilia

ORDER CROCODYLIA—CROCODILIANS

Family Alligatoridae—Alligators

American Alligator (p. 201)	*Alligator mississippiensis* (Daudin, 1801)

ORDER TESTUDINES—TURTLES

Suborder Cryptodira—Modern Turtles

Family Chelydridae—Snapping Turtles

Common Snapping Turtle (p. 214)	*Chelydra serpentina serpentina* (Linnaeus, 1758)
Alligator Snapping Turtle (p. 216)	*Macrochelys temminckii* (Harlan, 1835)

Family Emydidae—Pond, Marsh, River, and Box Turtles

Southern Painted Turtle (p. 219)	*Chrysemys picta dorsalis* Agassiz, 1857
Western Chicken Turtle (p. 220)	*Deirochelys reticularia miaria* Schwartz, 1956
Common Map Turtle (p. 222)	*Graptemys geographica* (Le Sueur, 1817)
Ouachita Map Turtle (p. 223)	*Graptemys ouachitensis ouachitensis* Cagle, 1953
Mississippi Map Turtle (p. 225)	*Graptemys pseudogeographica kohnii* (Baur, 1890)
Eastern River Cooter (p. 226)	*Pseudemys concinna concinna* (LeConte, 1830)
Eastern Box Turtle (p. 228)	*Terrapene carolina carolina* (Linnaeus, 1758)
Three-toed Box Turtle (p. 228)	*Terrapene carolina triunguis* (Agassiz, 1857)
Ornate Box Turtle (p. 230)	*Terrapene ornata ornata* (Agassiz, 1857)
Red-eared Slider (p. 232)	*Trachemys scripta elegans* (Wied-Neuwied, 1838)

Family Kinosternidae—Mud and Musk Turtles

Mississippi Mud Turtle (p. 234)	*Kinosternon subrubrum hippocrepis* Gray, 1855
Razorback Musk Turtle (p. 236)	*Sternotherus carinatus* (Gray, 1855)
Stinkpot (p. 238)	*Sternotherus odoratus* (Latreille, 1801)

Family Trionychidae—Softshells

Midland Smooth Softshell (p. 239)	*Apalone mutica mutica* (Le Sueur, 1827)
Western Spiny Softshell (p. 241)	*Apalone spinifera hartwegi* (Conant and Goin, 1948)
Pallid Spiny Softshell (p. 241)	*Apalone spinifera pallida* (Webb, 1962)
Eastern Spiny Softshell (p. 241)	*Apalone spinifera spinifera* (Le Sueur, 1827)

ORDER SQUAMATA—LIZARDS AND SNAKES

Suborder Sauria—Lizards

Family Anguidae—Glass Lizards

Western Slender Glass Lizard (p. 250)	*Ophisaurus attenuatus attenuatus* Cope, 1880

Family Crotaphytidae—Collared Lizards

Eastern Collared Lizard (p. 252)	*Crotaphytus collaris* (Say, 1823)

Family Phrynosomatidae—Horned and Spiny Lizards

Texas Horned Lizard (p. 255)	*Phrynosoma cornutum* (Harlan, 1825)
Northern Fence Lizard (p. 256)	*Sceloporus undulatus hyacinthinus* (Green, 1818)

Family Polychrotidae—Anoles

Northern Green Anole (p. 258)	*Anolis carolinensis carolinensis* (Voigt, 1832)

Family Scincidae—Skinks

Southern Coal Skink (p. 260)	*Eumeces anthracinus pluvialis* Cope, 1880
Five-lined Skink (p. 261)	*Eumeces fasciatus* (Linnaeus, 1758)
Broadhead Skink (p. 263)	*Eumeces laticeps* (Schneider, 1801)
Great Plains Skink (p. 265)	*Eumeces obsoletus* (Baird and Girard, 1852)
Southern Prairie Skink (p. 266)	*Eumeces septentrionalis obtusirostris* Bocourt, 1879
Ground Skink (p. 268)	*Scincella lateralis* (Say, 1823)

Family Teiidae—Racerunners and Whiptail Lizards

Six-lined Racerunner (p. 269)	*Cnemidophorus sexlineatus sexlineatus* (Linnaeus, 1766)
Prairie Racerunner (p. 269)	*Cnemidophorus sexlineatus viridis* Lowe, 1966

Suborder Serpentes—Snakes

Family Colubridae—Colubrid Snakes

Subfamily Colubrinae—Harmless, Egg-laying Snakes

Northern Scarlet Snake (p. 291)	*Cemophora coccinea copei* Jan, 1863
Buttermilk Racer (p. 293)	*Coluber constrictor anthicus* (Cope, 1862)
Eastern Yellowbelly Racer (p. 293)	*Coluber constrictor flaviventris* Say, 1823
Blackmask Racer (p. 293)	*Coluber constrictor latrunculus* Wilson, 1970

Southern Black Racer (p. 293)	*Coluber constrictor priapus* Dunn and Wood, 1939
Great Plains Rat Snake (p. 296)	*Elaphe guttata emoryi* (Baird and Girard, 1853)
Western Rat Snake (p. 298)	*Elaphe obsoleta* (Say, 1823)
Prairie Kingsnake (p. 302)	*Lampropeltis calligaster calligaster* (Harlan, 1827)
Speckled Kingsnake (p. 304)	*Lampropeltis getula holbrooki* Stejneger, 1902
Louisiana Milk Snake (p. 306)	*Lampropeltis triangulum amaura* Cope, 1860
Red Milk Snake (p. 307)	*Lampropeltis triangulum syspila* (Cope, 1888)
Eastern Coachwhip (p. 309)	*Masticophis flagellum flagellum* (Shaw, 1802)
Rough Green Snake (p. 312)	*Opheodrys aestivus* (Linnaeus, 1766))
Ground Snake (p. 314)	*Sonora semiannulata* Baird and Girard, 1853

Subfamily Natricinae—Harmless, Live-bearing Snakes

Mississippi Green Water Snake (p. 316)	*Nerodia cyclopion cyclopion* (Duméril, Bibron, and Duméril,1854)
Yellowbelly Water Snake (p. 318)	*Nerodia erythrogaster flavigaster* (Conant, 1949)
Blotched Water Snake (p. 318)	*Nerodia erythrogaster transversa* (Hallowell, 1852)
Broad-banded Water Snake (p. 320)	*Nerodia fasciata confluens* (Blanchard, 1923)
Diamondback Water Snake (p. 323)	*Nerodia rhombifer rhombifer* (Hallowell, 1852)
Midland Water Snake (p. 325)	*Nerodia sipedon pleuralis* (Cope, 1892)
Graham's Crayfish Snake (p. 328)	*Regina grahamii* Baird and Girard, 1853
Gulf Crayfish Snake (p. 330)	*Regina rigida sinicola* (Huheey, 1959)
Queen Snake (p. 332)	*Regina septemvittata* (Say, 1825)
Texas Brown Snake (p. 333)	*Storeria dekayi texana* Trapido, 1944
Midland Brown Snake (p. 333)	*Storeria dekayi wrightorum* Trapido, 1944
Northern Redbelly Snake (p. 336)	*Storeria occipitomaculata occipitomaculata* (Storer, 1839)
Florida Redbelly Snake (p. 336)	*Storeria occipitomaculata obscura* Trapido 1944
Western Ribbon Snake (p. 338)	*Thamnophis proximus proximus* (Say, 1823)
Eastern Garter Snake (p. 340)	*Thamnophis sirtalis sirtalis* (Linnaeus, 1758)
Rough Earth Snake (p. 343)	*Virginia striatula* (Linnaeus, 1766)
Western Smooth Earth Snake (p. 344)	*Virginia valeriae elegans* Kennicott, 1859

Subfamily Xenodontinae—Rear-fanged (Harmless), Egg-laying Snakes

Midwest Worm Snake (p. 346)	*Carphophis amoenus helenae* (Kennicott, 1859)
Western Worm Snake (p. 347)	*Carphophis vermis* (Kennicott, 1859)
Prairie Ringneck Snake (p. 349)	*Diadophis punctatus arnyi* Kennicott, 1859
Mississippi Ringneck Snake (p. 352)	*Diadophis punctatus stictogenys* Cope, 1860
Western Mud Snake (p. 353)	*Farancia abacura reinwardtii* (Schlegel, 1837)
Eastern Hognose Snake (p. 354)	*Heterodon platirhinos* Latreille, 1801
Flathead Snake (p. 358)	*Tantilla gracilis* Baird and Girard, 1853

Family Elapidae—Eastern Coral Snakes

Texas Coral Snake (p. 360)	*Micrurus tener tener* (Baird and Girard, 1853)

Family Viperidae—Pitvipers

Southern Copperhead (p. 362)	*Agkistrodon contortrix contortrix* (Linnaeus, 1766)
Osage Copperhead (p. 362)	*Agkistrodon contortrix phaeogaster* Gloyd, 1969
Western Cottonmouth (p. 365)	*Agkistrodon piscivorus leucostoma* (Troost, 1836)
Western Diamondback Rattlesnake (p. 368)	*Crotalus atrox* Baird and Girard, 1853
Timber Rattlesnake (p. 370)	*Crotalus horridus* Linnaeus, 1758
Western Pigmy Rattlesnake (p. 374)	*Sistrurus miliarius streckeri* Gloyd, 1935

About Species and Subspecies

A species can be defined as a group of interbreeding organisms that shares a common gene pool and that is reproductively isolated and evolving away from other such groups. The above is commonly referred to as the biological species concept and is just one of several species concepts that are in use in herpetological taxonomy (Frost and Hillis, 1990; Mayr and Ashlock, 1991). Species are often distinctive entities and can be easily recognized and separated from other species by simply noting contrasting external morphological features, such as color pattern. Yet, in some instances, color pattern may actually mask diverging genetic lineages within a herp species (as in *Elaphe obsoleta;* **see below**) and, thus, not provide the necessary information for recognizing evolutionary groups. Individual variation, however, exists within all populations of sexually reproducing species due to natural selection acting upon the gene pool or through genetic recombination of alleles. Moreover, individuals may also exhibit striking phenotypic differences related to sexual dimorphism, age, polymorphisms, and life-history adaptations (Mayr and Ashlock, 1991). As a result, species recognition usually requires some knowledge of a suite of

FIG. 3. Eastern racers. At left, *Coluber c. priapus* (Greene County); at right, *C. c. latrunculus* (Craighead County).

diagnostic characters, both morphological and molecular, that are typically used today by taxonomists when identifying one species from another.

Most contemporary morphologists and systematists employ cladistic methodology (an evolutionary system utilizing branching diagrams to illustrate common derived traits shared by two or more species) when classifying vertebrates. This procedure groups organisms based upon their phylogenetic (or historical) relationships; the underlying theory is that new species arise by the splitting of a stem species into two daughter species (Mayr and Ashlock, 1991). For example, vertebrae are common to all vertebrates, but this primitive feature would not be a practical criterion to a cladist in separating vertebrates. The cladist groups organisms based upon a chosen number of **shared, derived** anatomical features; therefore, the more closely an organism is related to another, the more shared features they possess. The phylogenetic species concept arose to explain this degree of closeness due to recent shared ancestry as compared to an overall similarity vertebrate organisms may share among each other (see Frost and Hillis, 1990).

There are some herp species in which the male sex is absent; these species reproduce unisexually by a process called *parthenogenesis.* Offspring from these all-female (or uniparental) species are often identical replicas of one another. Examples include some members of the whiptail lizard genus *Cnemidophorus* in the southwestern United States and Mexico. There are other species that are bisexual or unisexual but differ little morphologically and are called sibling species. For instance, two plethodontid salamanders in the Ouachita Mountains of Arkansas (the western slimy salamander *[Plethodon albagula]* and the Kiamichi Mountain salamander *[P. kiamichi]*) are of this type; so is the *Hyla chrysoscelis/Hyla versicolor* complex of gray treefrogs. These species look nearly identical or very similar to one another.

Some species are said to be polytypic (contain two or more races) or that they possess geographic variations in morphology (e.g., eastern racers [genus *Coluber*] from two contiguous counties in Arkansas; Fig. 3). Geographic populational variants of this type are sometimes regarded by biologists as microgeographic **races** (**subspecies**) of a species. Mayr and Ashlock (1991) define a subspecies as an aggregate of phenotypically similar populations of a species inhabiting a geographic subdivision of the range of that species and differing taxonomically from other populations of that species. The ranges of subspecies often merge resulting in intrapopulational variants (called *intergrades*) in the zone of overlap. Subspecies in this situation are said to intergrade with one another; that is, they exhibit a blending together of some features of each subspecies. Yet, in the case of North American rat snakes (genus *Elaphe*), subspecific designation based predominately upon color pattern can actually obscure distinct genetic lineages (Burbrink et al., 2000).

Many species also exhibit gradual changes in morphological features, such as body color and size, as habitats and climates change. If these character differences vary independently from one another, they are said to be clinal in nature; that is, they vary from one extreme to another. Because of clines and the degree to which members of a localized population (sometimes called a *deme*) vary, the assignment of subspecies to a given population can often be problematic for biologists.

In this book, we adhere to the biological species concept and also recognize herpetofaunal subspecies as provided by Conant and Collins (1998) for a majority of the herps inhabiting Arkansas. In some species descriptions, we detail individual subspecies as separate taxonomic units in a **Species Account**; in other cases, when a subspecies is poorly known or ill defined within Arkansas, this subspecies and any purported zones of intergradation may be discussed in the **Subspecies** or **Remarks** section of a species account. For current standard common names of a species and/or subspecies, we have primarily complied with the usage of Collins (1997) and/or Conant and Collins (1998). United States species range maps were also adapted from Conant and Collins (1998). For standard scientific names, we have primarily followed the most recent taxonomic usage found in Moriarty (2000). We also address within the **Remarks** section any taxonomic name changes or other matters pertaining to current scientific name usage.

Ecoregions of Arkansas

The diverse assemblage of amphibians and reptiles found in Arkansas has resulted in part from the state's geographic position and its physical features. Arkansas has a number of species whose broad geographic ranges center in or near the state. Furthermore, due to its geographic position, western species reach their eastern limits in Arkansas, eastern species reach their western limits, coastal plain species reach their northern limits, remnant populations of northern species lie at their southern limits, and several endemic species are found nowhere else. In addition to the state's geographic position, Arkansas contains distinct areas defined by physical features such as geology and topography that also affect the state's herpetological diversity. These ecological units, called natural divisions or ecoregions, substantially influence the distribution and abundance of amphibians and reptiles. The general features of these regions are described below; more detailed descriptions may be found in Foti (1974), Foti and Bukenhofer (1998), and references therein.

Arkansas may be divided into two great regions (Interior Highlands and Gulf Coastal Plain) that are approximately equal in area and rather sharply demarcated from each other (Fig. 4). The Interior Highlands in the northern and western half of the state rises to over 850 m in elevation and is locally rugged topographically. Recurrent uplifting and erosion beginning in the Paleozoic Era formed these mountains. Surface material consists of older consolidated sedimentary rocks. Characteristic vegetation consists of upland hardwood and pine-hardwood forests. In contrast, the Gulf Coastal Plain in the southern and eastern part of the state, is basically an elevated sea bottom, rising to a maximum 200 m and exhibiting little topographic relief. In the Cretaceous, the waters of the Gulf of Mexico completely inundated the plain. Portions of it have since been eroded and received alluvial deposits from large rivers, so that its surface consists of recent unconsolidated material. Characteristic vegetation consists of bottomland hardwood forest. The boundary between the highlands and lowlands may be distinct in certain areas so that an abrupt "Fall Line" is apparent.

Interior Highlands

OZARK HIGHLANDS (OZARKS)

The Interior Highlands consists of three distinctive regions,—the Ozark Highlands, the Arkansas Valley, and the Ouachita Mountains (Fig. 4). The Ozark Highlands was horizontally uplifted as three great plateaus and owe their ruggedness to erosion by numerous streams. These regions frequently have pronounced escarpments at their boundaries. Undulating to hilly surfaces, bounded by more rugged relief, characterize the two plateaus of the Highlands. The lower and more eastern Salem Plateau consists of irregular plains 90–500 m in elevation and hills with entrenched valleys 180–500 m in elevation. Its surface is mostly Ordovician limestone or dolomite with some sandstone (Fig. 5) and shale. Relief seldom exceeds 60 m. Major habitats include prairies, oak woodlands and forests, and alkaline glades. Pine-oak woodlands and

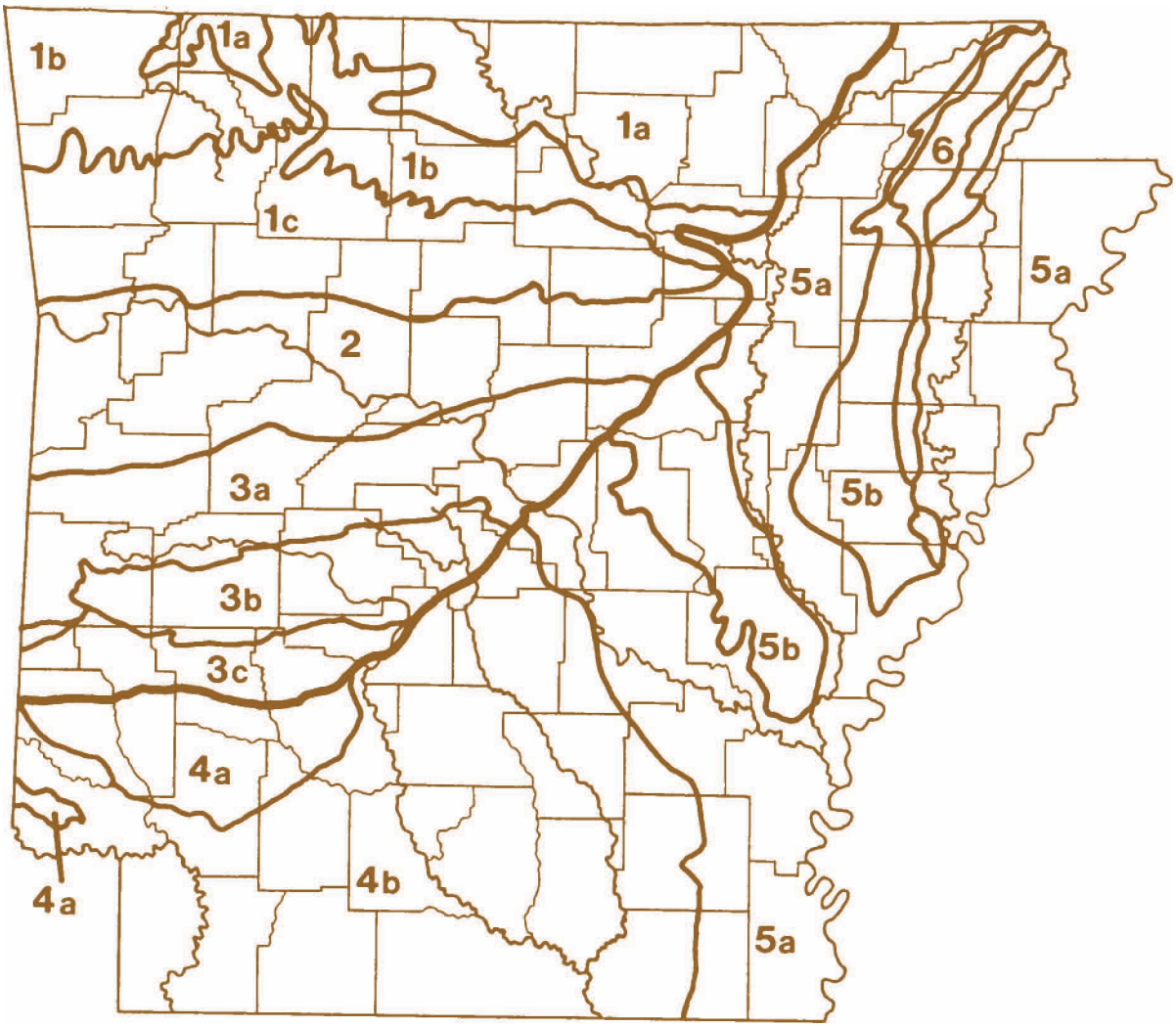


FIG. 4. The ecoregions of Arkansas. See Foti (1974) and Foti and Bukenhofer (1998) for additional information, especially on the subdivisions. Map redrawn from Smith et al. (1984).

A. Interior Highlands (left of heavy line on map)
   1. Ozark Highlands (Ozarks)
      A. Salem Plateau subdivision
      B. Springfield Plateau subdivision
      C. Boston Mountains subdivision
   2. Arkansas Valley
   3. Ouachita Mountains
      A. Fourche Mountains subdivision
      B. Central Ouachita Mountains subdivision
      C. Athens Plateau subdivision

B. Gulf Coastal Plain (right of heavy line on map)
   4. West Gulf Coastal Plain
      A. Southwestern Arkansas
      B. Southcentral Arkansas
   5. Mississippi Alluvial Plain (Delta)
      A. Bottomlands subdivision
      B. Loessial Plains subdivision
   6. Crowley's Ridge

FIG. 5. Sandstone/limestone cedar glade habitat near Calico Rock (Izard County). Glades are optimal habitats for the eastern collared lizard *(Crotaphytus collaris)* and the eastern coachwhip *(Masticophis f. flagellum)*.

forests often occur on cherty escarpments and sandstone areas. The higher and more western Springfield Plateau consists of smooth to irregular plains 240–425 m in elevation; its surface consists of Mississippian limestone and chert (Fig. 6). Major habitats include prairies, oak woodlands and forests, and alkaline and acid glades. Relief of 60–90 m occurs along streams, but there are extensive relatively level areas (Fig. 7). The Boston Mountains is a rugged, highly dissected plateau limited on the north by a conspicuous escarpment. It is capped with Pennsylvanian sandstone and shale, layers which have been removed from the more northern Salem and Springfield plateaus. Elevation in the Boston Mountains ranges from 150 to 825 m, and local relief may exceed 450 m (Fig. 8). Valleys are typically steep sided and narrow with no flood plains. Soils are usually well drained and rocky, deep in valleys and flatter areas but thin on hillsides. Oak woodlands and forests predominate with major areas of pine-oak woodlands and forests on southern slopes. Limestone is one of the most abundant rocks in the Ozarks. Due to its solubility, subsurface streams and caves abound and many springs occur in the valleys. The only natural lakes in the entire state, except for oxbow lakes in the larger Delta streams, are limestone sinkholes in the Springfield Plateau.

ARKANSAS VALLEY

The Arkansas Valley is the trough lying between the Boston and Ouachita mountains (Fig. 4). Structurally, the Arkansas Valley is more similar to the Ouachita Mountains; major differences are that the geological folds are more open and gentle and the elevation is lower. Much of the valley is gently rolling lowlands, 90–150 m in elevation, and contains the alluvial valley through which the Arkansas River meanders (Fig. 9). But also within the valley are isolated mountains, ridges, and mesas ranging up to 300 m, and the highest elevation (860 m) and greatest topographic relief in the state at Magazine Mountain (Fig. 10). While the valley often merges imperceptibly with the Ozarks on the north or with the Ouachitas on the south, in some areas there are abrupt elevational changes at the boundaries (Fig. 11). Surface rocks are primarily Pennsylvanian sandstone and shale with Pleistocene and Recent alluvium along the river and its larger tributaries. A diverse assemblage of pine-oak and pine woodlands and forests dominates the uplands on moderately permeable loams, while substantial bottomland hardwood forests occur on the lower alluvial soils. Isolated prairies also occur in the valley.

FIG. 6. Limestone bluffs along the White River (Independence County) are often pocketed with caves whose inhabitants include the cave salamander *(Eurycea lucifuga)* and the grotto salamander *(Typhlotriton spelaeus).*

FIG. 7. Typical prairie landscape near Siloam Springs (Benton County) in northwestern Arkansas. Common species in prairie habitats include the western slender glass lizard *(Ophisaurus a. attenuatus),* the three-toed box turtle *(Terrapene carolina triunguis),* the prairie kingsnake *(Lampropeltis c. calligaster),* and the eastern yellowbelly racer *(Coluber constrictor flaviventris).*

FIG. 8. Boston Mountains near Mountainburg (Crawford County) exhibit the high relief and steep valley contours typical of this region. The wood frog *(Rana sylvatica)* and disjunct populations of the queen snake *(Regina septemvittata)* inhabit the upland woodlands and south-flowing streams, respectively, in these mountains.

FIG. 9. Temporary lowland pool north of Petit Jean Mountain along the Arkansas River (Conway County) provides a breeding habitat for the eastern narrowmouth toad *(Gastrophryne carolinensis),* Hurter's spadefoot *(Scaphiopus holbrookii hurterii),* and Fowler's toad *(Bufo fowleri).*

FIG. 10. Magazine Mountain, the highest elevation point in Arkansas (Logan County). This rugged mountainous terrain provides suitable habitat for the timber rattlesnake *(Crotalus horridus).*

FIG. 11. Pinnacle Mountain rises abruptly above the Arkansas River in Pulaski County (Fourche Mountain subdivision). Lizards, such as the northern fence lizard *(Sceloporus undulatus hyacinthinus)* and the five-lined skink *(Eumeces fasciatus),* are common residents on this rocky, wooded mountaintop.

OUACHITA MOUNTAINS

The Ouachita Mountains contrast with the Ozarks in their mode of formation, in topography, and in vegetation. Rather than being uplifted plateaus, most of the Ouachita system formed as a result of extensive folding and faulting, and probably it is a western extension of the folded Appalachian system. Erosion has occurred, but the ruggedness of these east-west trending mountains is largely due to basic formative processes. The different regions may be recognized by the spacing of the folds. Only the southernmost portion (Athens Piedmont Plateau) is a relatively level uplifted area (120–300 m elevation). The Fourche Mountain Region, the largest subdivision of the Ouachitas, is a series of parallel east-west, narrow, rugged ridges with maximum topographic relief (300 m) and elevation (850 m) toward the western end (Fig. 12). About half of the total area of this region is composed of broad, uneven valley floors with some flood plains. The surface of this region and that of the Athens Piedmont Plateau is largely Mississippian sandstone and shale. The large Central Ouachita Mountain Region is bounded almost entirely by outcrops of Devonian Novaculite and is capped by Ordovician and Silurian sandstone and shale and some igneous rocks. This is a complex region of closely folded valleys and mountains ranging 230–760 m in elevation. Elevations of 600 m are common near the center and in the west. While the trend is generally east-west, ridge orientation and local topography can be quite varied. Local relief ranges from approximately 90–275 m. The basin floors among the ridges generally are uneven; however, there are broad swampy areas in the Saline River Basin. Most Ouachita streams flow along the valleys (Fig. 13), but some streams flow south across the east-west ridges forming spectacular falls and rapids at each ridge. Ouachita soils may be deep in valleys but are very shallow and stony on ridges (Fig. 14). Pine-oak and oak woodlands and forests predominate throughout the Ouachitas with prairies occurring in the more western portions. North slopes receive less direct solar radiation than south slopes and thus are generally cooler, moister, and support more mesic vegetation. This phenomenon occurs throughout the Interior Highlands but is more obvious in the closely folded east-west oriented ridges of the Ouachitas.

FIG. 12. Rich Mountain (Black Fork Mountain in the background) at the western edge of the Fourche Mountain region in southwestern Arkansas. Salamanders species commonly found on Rich Mountain include three terrestrial forms (western slimy, *Plethodon albagula;* southern redback, *Plethodon serratus;* and Rich Mountain, *Plethodon ouachitae*) and two streamside forms (Ouachita dusky, *Desmognathus brimleyorum,* and many-ribbed, *Eurycea m. multiplicata*). The western worm snake *(Carphophis vermis)* and the Mississippi ringneck snake *(Diadophis punctatus stictogenys)* are common during the springtime.

FIG. 13. Little Missouri River near Albert Pike Recreational Campground (Montgomery County). Species common in or along aquatic habitats such as this one in the Caddo Mountains include the midland water snake *(Nerodia sipedon pleuralis)* and Blanchard's cricket frog *(Acris crepitans blanchardi)*. The Caddo Mountain salamander *(Plethodon caddoensis)*, an endemic species in this region, can be found on hillsides bordering this stream.

FIG. 14. This steep, rocky, west-facing ridge near Aplin (Perry County) is habitat for the western diamondback rattlesnake, *(Crotalus atrox)*, the northern scarlet snake *(Cemophora coccinea copei)*, the flathead snake *(Tantilla gracilis)*, and the northern green anole *(Anolis c. carolinensis)*.

Gulf Coastal Plain

WEST GULF COASTAL PLAIN

The Gulf Coastal Plain may be separated into two distinct regions, the West Gulf Coastal Plain and the Mississippi Alluvial Plain (Fig. 4). The West Gulf Coastal Plain varies in elevation from 60–200 m and has generally a rolling to hilly topography. Three north- and west-facing cuestas in southwestern Arkansas represent ancient shorelines of the Gulf of Mexico. Surface deposits are unconsolidated ocean-bed sediments of Cretaceous and Tertiary age. Soils are well-drained sandy loams and support relatively uniform pine-hardwood forests except along major streams (especially the Red [Fig. 15], Ouachita, and Saline rivers) where soils and plant communities resemble those of the Mississippi Alluvial Plain. Scattered small prairies may be found in some areas of southwestern Arkansas.

MISSISSIPPI ALLUVIAL PLAIN (DELTA)

The Mississippi Alluvial Plain, frequently called the Delta, varies in elevation from 30–90 m and has generally a flat to slightly undulating topography. Geologically known as the Mississippi Embayment, the Delta is a vast, structural trough, portions of which are probably still sinking as evidenced by the New Madrid Earthquake of 1811 and 1812. Surfaces are recent alluvia of sand, silt, and clay deposited by large rivers. The Arkansas, White, St. Francis, Mississippi, and even the Ohio at one time have flowed through this region and have been major factors in shaping the land. Soils are extremely deep and often poorly drained. A majestic bottomland hardwood forest once covered the entire Delta except for the Grand Prairie, a 160,000 hectares (ha) treeless area which developed over hardpan subsoil in Lonoke, Monroe, and Arkansas counties. Today, due to the demands of agriculture and flood control, approximately 90 percent of the Delta forest has been cleared (Fig. 16) and hardly a natural stream remains. In each year from 1960 to 1970, an estimated 60,000 ha of Delta timberlands (Fig. 17) were cleared, 90 percent for the purpose of growing soybeans. In addition to the obvious loss of structural habitat, the ecology of the Delta has been drastically changed by increased solar radiation to normally shaded substrates and by depressed water tables. In some places the water table dropped 5 m in nine years.

FIG. 15. Red River near its confluence with the Little River (Little River County). The sandy shoreline habitat is suited for the nesting habits of map (*Graptemys* sp.) and softshell turtles (*Apalone* sp.).